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CONVERSION OF EXOSKELETON WASTE TO OILFIELD CHEMICAL FOR DRILLING FLUID DESIGN

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***Abstract* -** Managing lost circulation has always been a huge challenge in the oil industry and the situation becomes more complicated when the formation is fractured or shale formation is involved. However, particulate lost circulation materials (LCMs) have been used to prevent the drilling fluid from entering fractured, cavernous, or high-permeability formations for many years. This study aimed at investigating the efficacy of Snail Shells as filtration loss control additives in water-based drilling muds. The filtration characteristics of the formulated mud samples were tested using American Petroleum Institute (API) filter press and in accordance with API recommended practice for field testing water-based drilling fluids (API RP 13B-1). The experimental study showed that the viscosity of snail shells and calcium carbonate water-based muds were affected by rotational speed. Experimental results of fluid loss for snail shell and calcium carbonate were 6 MLS and 5.8 MLS respectively. Furthermore, the characterization of the Chemical Compound. Composition of Snail Shell and Calcium Carbonate and results show that they have similar characteristics. Therefore, the result shows that snail shell is a better substitute for calcium carbonate in water-based drilling fluid design. Moreso, experimental study has been able to prove that what constitutes environmental degradation is converted to oilfield chemical additive in drilling fluid design.

Keywords: *Snail shell, calcium carbonate, fluid loss, lost circulation, viscosity*

I. INTRODUCTION

The rotary drilling process, the most widely used drilling method in the oil and gas industry, involves the circulation of drilling fluids. These fluids in their liquid form are called water-based drilling mud (if water is the continuous phase) or oil-based drilling mud (if oil is the continuous phase). Rapid filtration of drilling fluid into surrounding permeable formations occurs during drilling operations, resulting in lost circulation problems. Fluid loss is minimized by the creation of low permeable filter cake at the surface of the wellbore, which prevents solid particles from flowing into the pores of the formation together with the continuous phase [1]. These solid particles tend to plug the pore spaces of the formation either by physical or chemical processes, thereby reducing the permeability and porosity of the formation and by so doing, hamper the flow of fluids through such formations to the wellbore. This is generally referred to as formation damage. Formation damage associated with drilling mud occurs when particles (such as drill solids, weighting agents, and/or soft particles like polymers) invade the reservoir rock, thus plugging pores and forming an internal filter cake.
Most Particulate materials contained in water-base mud (clays, cuttings, and weighting agents) are potentially damaging, and if forced into the pay zone, they can progressively fill the pores of the reservoir rock. Any subsequent production of hydrocarbon or injection of fluids at moderate or high flow rates will cause these materials to bridge over pore throat entries and severely decrease permeability near the wellbore region [2]. Such a damaging process is limited to the first few inches around the wellbore (an average value of 3 in. (7.5 cm) is commonly used), but the resultant permeability reduction can be as high as 90%. Invasion of formation rock by drilling fluid solids is favored by the large pore size of the formation rock, presence of fissures and natural fractures in the reservoir, the small particle size of the solid components of the drilling fluid (weighting agents and lost-circulation preventers whose initial particles are usually coarse and can be fragmented by the

drilling bit), low drilling rate resulting in mud cake destruction (mud loss increase) and long mud-to-formation contact time, high drilling fluid circulation rate (mud cake erosion), high drilling fluid density causing large overbalance pressure, and scrapping mud cake which provokes pressure surges and increases formation-to-mud contact time during bit trips.

Water-based mud filtrates may have a low salinity and a high pH and may contain dispersants and polymers. Polymers are stable at circulating temperatures but can decompose and form residues when subjected to static reservoir temperatures for long periods. High salinity water-base mud generates filtrates that can react with formation brines and precipitate various types of scale.

Formations drilled at high circulation rates are invaded by filtrates with temperatures well below the reservoir temperature. The cooling they cause may provoke the deposition of paraffin and/or asphaltenes [3]. These numerous drawbacks of water-base drilling fluid led to the development of oil-based mud for drilling through clayey sandstone [4]. The initial conclusion was that this new mud was a safe, all-purpose drilling fluid. It is now recognized, however, that although the problems of oil-base mud are less numerous than those of water base mud, they are often much more severe [5]. Oil-based mud contains more solids than water-based mud. Consequently, particle invasion is more pronounced. Several types of materials are used to reduce particle invasion (filtration rate) and improve mud cake characteristics. Since filtration problems usually are related to the flocculation of the active clay particles, deflocculants also aid filtration control. When clays cannot be used effectively as deflocculating agents, water-soluble polymers are substituted. Particulate invasion of the region around the wellbore, subsequent solid entrainment, as well as loss of circulation, are the major formation damage mechanisms associated with water-base drilling mud. These mechanisms usually lead to the formation of a zone of altered permeability around the wellbore (skin effect), which adversely affects the productivity of such well. During hydrocarbon production, backflow with hydrocarbons may partially clean up the internal filter cakes, but general, the permeability of the invaded region is seriously impaired such that hydrocarbon production is reduced.

Functions of Bridging Agent Additives

Solids are added to a drilling fluid to bridge across the pore throat or fractures of exposed rock, thereby building a filter cake to prevent loss of whole mud or excessive filtrate. Bridging materials are commonly used in drilling fluids and lost circulation treatments. For reservoir applications, the bridging agent should be removable; common products include calcium carbonate (acid-soluble), suspended salt (water-soluble), or oil-soluble resins. For lost-circulation treatments, any suitably sized products can be used, including mica, nutshells, and fibers. These products are more commonly referred to as lost-circulation material (LCM) [6] In oil or gas, well drilling lost circulation [7] occurs when drilling fluid, known commonly as "mud", flows into one or more geological formations instead of returning up the annulus. Lost circulation can be a serious problem during the drilling of an oil well or gas well.

Theoretical Background of Snail Shell

A snail is, in loose terms, a shelled gastropod. The name is most often applied to land snails and terrestrial pulmonate gastropod molluscs. However, the common name *snail* is also used for most of the members of the molluscan class Gastropoda that have a coiled shell that is large enough for the animal to retract completely. The visible features in snails are; Columella, Lip, Suture, Pinnacle, Whorls, Parietal wall, and Spire. The various snail types are grouped into; land snails, sea snails, and freshwater snails. When the word "snail" is used in this most general sense, it includes not just land snails but also numerous species of sea snails and freshwater snails. Gastropods that naturally lack a shell, or have only an internal shell, are mostly called slugs, and land snails that have only a very small shell (that they cannot retract into) are often called semi-slugs. Snails have considerable human relevance, including as food items, as pests, and as vectors of disease, and their shells are used as decorative objects and are incorporated into jewelry. The snail has also had some cultural significance, tending to be associated with lethargy. The snail has also been used as a figure of speech about slow-moving things. The snail is the same or similar shape as the cochlea [7]

Snail Shell and Its Availability in Nigeria

There are many different types of snails found in Nigeria, each with their own unique characteristics and habitats which include the sea, land and fresh water habitats and they are distinguished by their various specific features [8]. The possibility of being able to easily distinguish between snails is low but this can be done confidently when proper attention is paid to the details. Like limestone, their shells are chiefly composed of $CaCO_3$.

Convert Waste to Wealth

Waste can be regarded as an unwanted and harmful material produced as a result of man's interaction with nature in an unsustainable

manner. The interaction conflict becomes constant due to the increasing human needs and desire to satisfy endless wants which in turn makes waste management an indispensable task in achieving sustainable development. Wastes are not prime products produced from the market, do not occur in normal commercial and utility circle possess potential for further use in production, transformation or consumption [9] [10]. Waste can be understood based on their cardinal processes source, effect on human environment and the control which are appropriate to deal with it. These exoskeletons once discarded become an industrial waste creating environmental pollutant thus, exoskeletons are restricted to growth; stretch or expand. Though is non-toxic, biodegradable and biocompatible [11].
This study aimed at investigating experimentally study the exoskeleton waste (land Snail shell) as lost circulating reducer in water-based fluid.

II. METHODOLOGY

Apparatus and Materials

The apparatuses used for the experiments were conical flask, beakers, pH meter, abroad mud balance, jaw crushers, BS sieve, wire mesh, furnace, thermometer, stopwatch, graduated cylinder, API filter press, fann viscometer, weighing balance and mixer. The raw materials (additives) were used for the experiment as shown in tables 1 and 2.

Table 1: Raw Materials/additives and their functions

Raw Material/Additive	Function
Water	Continuous phase
Caustic Soda	pH modifier (to add alkalinity to the mud)
Soda Ash	pH modifier (to add alkalinity to the mud)
Xanthium Gum	Viscosifier and fluid loss control agent
Bentonite	Lubricates and cools the cutting tools
Polyanionic Cellulose (PAC)	Viscosifier and fluid loss control agent
Potassium Chloride (KCl)	Shale Hydration Inhibitor
Barite	Weighting agent
Snail Shell Ash	Filtration control agent
$CaCO_3$	Filtration control agent

Preparation of Snail Shell

The snail shells used for this work were sourced from the local market in Anambra State, Nigeria. The snail shells were soaked overnight in warm water treated with Sodium Chloride (NaCl) to remove dirt and any contaminants. Thereafter, snail shells were washed and air dried, and then heated in an electric muffle furnace at 995 ^{0}C. The calcined shells were then crushed with the aid of a jaw crusher and ground to fine particles. The ensuing was then sieved through a BS sieve (75 microns) to obtain fine ash (nanoparticles). These fine particles as shown in Plate 1 as used for the formulation of the mud sample of interest.

Plate 1: Grinded Periwinkle Shells

Formulation of Water-Based Drilling Muds

To distinguish the effect of snail shell and calcium carbonate, three (3) different mud samples (A, B, and C) were formulated with varying amounts of the various additives using the drilling mud formulation template and guideline. The composition of the various mud samples is presented in Table 3. Each of the additives was introduced into the stirring mixture for 5 minutes. At the end of the last additive, a total of an hour was obtained for a homogenous mixture. The mud density is measured using mud balance, the pH of the mud is measured with the pH indicator, and the viscosity of the mud is also measured with the aid of a viscometer and fluid loss was obtained using the API filter loss cell. The dial reading thereafter of the formulated mud will be recorded at 600, 300, 200, 100, 6, and 3rpm with the help of a rheometer. Rheological properties of the various water-based drilling fluids at temperatures between 80^{0}F to 150^{0}F were obtained.

Table 2: Composition of Mud Samples

Additive	Sample A	Sample B	Sample C
Water (ml)	350	350	350
Caustic Soda (g)	0.2	0.2	0.2
Soda Ash (g)	0.2	0.2	0.2
Xanthium Gum (g)	1.5	1.5	1.5
Bentonite (g)	20	20	20
Polyanionic Cellulose (PAC) (g)	0.8	0.8	0.8
Potassium Chloride (KCl) (g)	25	25	25
Barite (g)	30	30	30
Snail Shell Ash (g)	--	3	--
$CaCO_3$ (g)	--	--	3

Determination of the Density of Drilling Fluid

1. First, the instrument was levelled;
2. Then the fill was cleaned and the dry cup was tested with mud then was put and rotated until was seated, was ensured that the mud was expelled through the hole in the cap to free the trapped gas,
3. The mud is swiped outside the cup and the beam was placed to support the balance because the beam is horizontal when the bubble is on the center line,
4. After that, the read was taken at the side of the rider towards the knife edge,

Rheological Test

The rheological measurements were conducted based on API RP 10B-2/ISO 10426-2. After

Drilling fluid was prepared, and it was transferred into the viscometer cup and subjected to shear in Fann direct-indicating viscometer. The torque response for each rotational speed provided by equipment (600, 300, 200, 100, 6, and 3 rpm) was recorded. At each rotation speed, the dial reading was taken when the speed of rotation was stabilized. At each test temperature of 80ºF to 150ºF, drilling muds were subjected to a rheological test and at each rotation speed, a dial reading was taken when the speed of rotation was stabilized.
Rheological values obtained from the viscometer and various calculations obtained from test results are shown below. Thus, the reference for measuring viscosity and performing calculations by American Petroleum Institute specifications API RP 13B-1/ISO 10414-1 (2016).

Calculation of plastic viscosity (PV) and yield point (YP):
Plastic viscosity (PV) and yield point (YP) of cement slurries were calculated using equations (1) and (2).

$$PV\ (cP) = (\theta_{600} - \theta_{300}) \quad (1)$$

$$YP\ \left(\frac{Ib}{100ft^2}\right) = \theta_{300} - PV \quad (2)$$

Where θ = dial reading

Gel strength at 10 seconds and gel strength at 10 minutes were obtained from the viscometer immediately after desired time, at first deflection. This is to the American Petroleum Institute Specification procedure (API RP 13B-1/ISO 10414-1, 2016).

Determination of pH Measurement of Drilling Fluid

For this measurement, a pH paper will be used, the paper was dipped into the mud to be tested and then the colour changes observed and then matched with their corresponding value.

API Fluid Loss Test
Fluid loss tests were conducted using static filter press assembly at ambient (room) temperature and 100-psi differential pressure and it was based on API RP 10B-2/ISO 10426-2. After the drilling fluid was prepared, it was transferred into a filter press consisting of a cylindrical drilling fluid cell having an inside diameter of 3 inches (76.2mm) and a height of at least 2.5 inches (64 mm). This chamber is made of materials resistant to strongly alkaline solutions and is so fitted that a pressure medium can be conveniently admitted into, and bled from the top. The arrangement is also such that a sheet of 90 mm (3.54 in.), the filter paper was placed at the bottom of the chamber just above a suitable support. The filtration area is (7.1 ± 0.1) in^2 (45.8 ± 0.6) cm^2. Below the support is a drain tube for discharging the filtrate into a graduated cylinder. Sealing is accomplished with gaskets. The entire assembly is supported by a stand. The pressure was applied with any non-hazardous fluids medium, either gas or liquid.

Procedure
i. Each part of the cell, particularly the screen was cleaned and dried, and the gaskets were not distorted or worn.
ii. Formulated drilling mud was poured into the cell to within 1cm to 1.5cm (0.4 into 0.6in) of the top to (minimize CO_2 contamination of filtrate) and the assembly was completed with the filter paper in place.
iii. A dry graduated cylinder was placed under the drain tube to receive the filtrate, the relief valve was closed and the regulators were adjusted so that a pressure of 100 psi ± 5psi (7.03 ± 0.356 Kg/sq cm.) is applied within 30 seconds or less. The test period (or duration of time) begins at, the time of pressure application.
iv. At the end of 30 minutes, the volume of the filtrate was measured. The pressure regulators were shut off and the relief valve was carefully opened. It may be desirable to use one-hour filtration tests for oil drilling fluids: the time interval is other than 30min. shall be reported.
v. Report the volume of filtrate in millilitre (to the nearest 0.1ml) as the API filtrate; also report the initial temperature in ºC (ºF).
vi. The cell is removed from the frame, first making certain that all pressure has been relieved.
vii. The cell was disassembled, the mud was discarded, and use extreme care to save the filter paper with a minimum of disturbance to the cake.
i. Wash the filter cake on the paper with a gentle stream of water
ii. Measure and report the thickness of the cake to the nearest millilitre.
iii. In the case of oil drilling fluids, diesel may be used in place of water for washing the cake.
iv. Clean and dry the apparatus thoroughly after each use.
v. Although cake descriptions are subjective, such notations as hard, firm, fine, tough, soft, rubbery, etc. may convey important information about cake quality.

Characterization of Chemical Compound Composition
Procedure:
1. The XRD **Rigaku MiniFlex 600 XRD** Diffractometer was powered and from the panel, the voltage and current were set at 30kV and 15 mA.
2. The temperature was set at 21-23ºC.

3. The computer system was switched on and the software of XRD, TUMI was double-clicked to run.
4. The settings dialogue was clicked and all the required settings of power and temperature were checked to correspond to that of the XRD.
5. The sample was poured into the sample holder and then placed in the sample chamber column. Then the door was shut and confirmed from the computer.
6. The measurement sets were then set for the scan-axis as Gonio, start and end positions were also set so as the angle and time of the scan.
7. The scan began and then stopped at the required time and the result was saved to a file.
8. The result obtained was then matched with a different library, such as the NIST and PubChem to get the chemical structure, name, and other physicochemical properties

Determination of Elemental Composition of Materials Using X-ray fluorescent (XRF)
Procedure:
1. The sample cup was prepared with a propylene thin film, ensuring the smoothness of the thin film surface.
2. The pulverized sample was poured into a thin film-covered cup with a sample filled to a third of the sample cup (**approx. 5g**).
3. The lid of the sample cup was covered and it was ensured that there were no leakages or loose particles on the thin film layer also lids are tightened shut.
4. The sample was then inserted into the sample turret of the Genius-IF Xenometric XRF sample chamber.
5. The X-ray Lamp was then powered and allowed to stabilize in 2 minutes On the RUN tab, Voltage, and Emission current values were set to ensure that the observed dead time is between 35-40kv;
6. The analysis was then RUN to obtain spectrum data. XRS-FP Crossroad scientific Software was then opened and the Master Oxide. The file was uploaded and then obtained the Spectra file of the sample was processed then saved and printed into a PDF file.

III. RESULTS PRESENTATION AND ANALYSIS

Comparative analyses of snail shells and calcium carbonate were carried out to ascertain their reduction in filtration loss; and their effect on rheological properties with respect to temperature in water-based drilling fluids. However, the results of the characterization of snail shell and calcium carbonate were obtained.

Effect of Rheological Properties of Water-Based Muds Formulated with Snail Shell and Calcium Carbonate
Formulation of water-based muds with snail shell and calcium carbonate was achieved with the aid of Hamitton Beach mixer and also the rheological properties were obtained using a rheometer at different temperatures of (80ºF – 150ºF). The experimental study showed that the viscosity of snail shell and calcium carbonate water-based muds were affected by rotational speed thus, there was a corresponding decrease in the viscosity of samples when subjected to high temperature as shown in Figures 1 to 2 respectively. This is in line with the concept of a dilatant (thixotropic) fluid condition in which viscosity increases with an increase in shear rate, thus obeying the non-Newtonian behavior of the fluid flow.

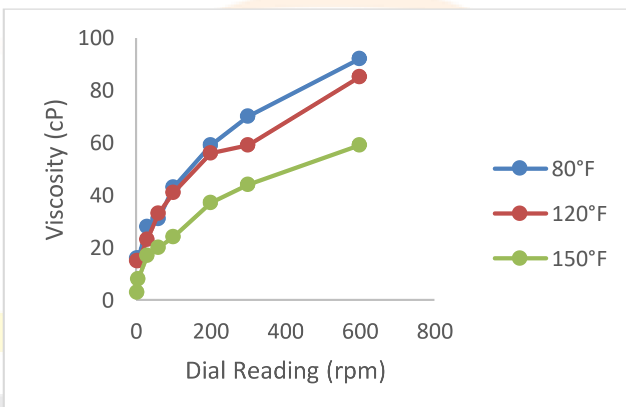

Figure 1: Viscosity vs Dial Reading of Snail Shell of Water-Based Drilling Fluid

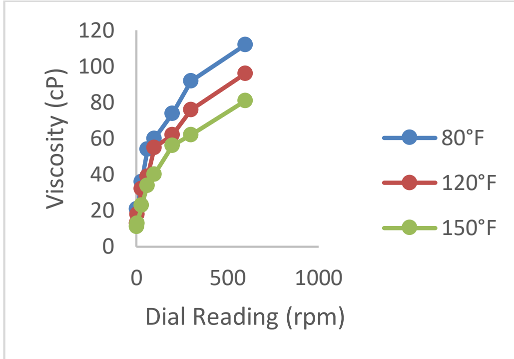

Figure 2: Viscosity vs Dial Reading of Calcium Carbonate of Water-Based Drilling Fluid

Effect of Temperature on the Plastic Viscosity of the Water-Based Drilling Fluid with Snail Shell and Calcium Carbonate
Experimental results showed non-linearity in the plastic viscosity with a corresponding increase in temperatures of the water-based drilling fluids formulated with snail shell, and calcium carbonate as shown in Figures 3 to 4. It was observed that at temperatures of 80ºF, 120 ºF, and 150 ºF plastic viscosities of water-based drilling fluid with snail shell, and calcium carbonate were 22 cP; 26 cP and 15 cP; 20 cP, 20 cP, and 20 cP respectively. However, it has proven the fact that most of the fluid loss additives have an effect on the rheological properties of water-based drilling fluids at higher temperatures despite the number of viscosifiers present in the design.

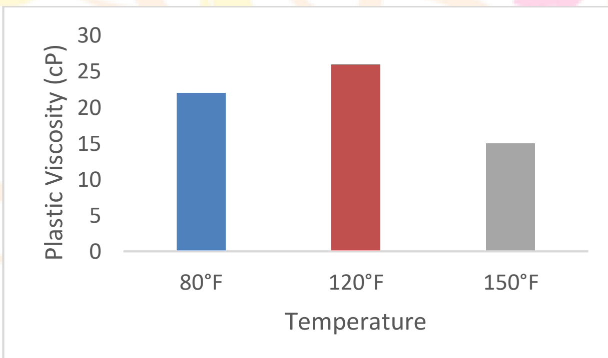

Figure 3: Plastic Viscosity vs Temperature of Snail Shell Water-Based Drilling Fluid

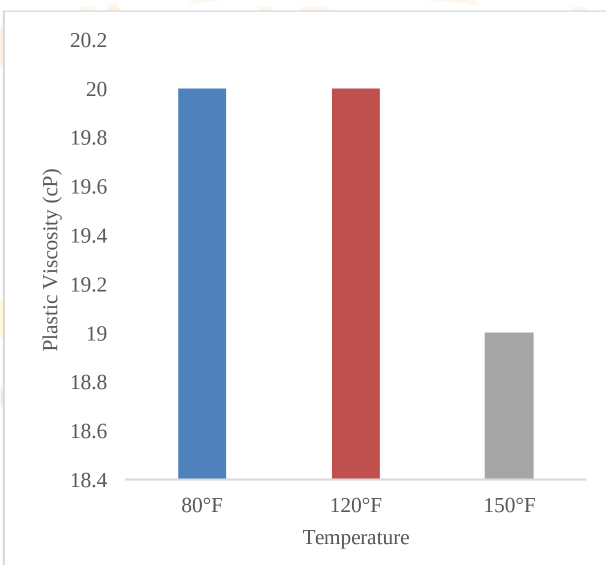

Figure 4: Plastic Viscosity vs Temperature of Calcium Carbonate Water-Based Drilling Fluid

Effect of Temperature on the Yield Point and Gel Strength of the water-based drilling fluid with Snail Shell and Calcium Carbonate
It was observed that there was an appreciable decrease in yield points and gel strength values with increasing temperatures in water-based muds formulated with snail shell, and calcium carbonate shown in Figures 4.8 to 4.10. Experimental results at temperatures of 80ºF, 120,

and 150 ºF of water-based drilling fluid at temperature of 80 ºF for snail shell and calcium carbonate were for yield points were 30 lb/100 ft^2, and 38lb/100ft^2; gel strength at 10 seconds were 6 lb/100 $ft^2$and 7 lb/100 ft^2; gel strength at 10 minutes were 7 lb/100 $ft^2$and 7 lb/100 ft^2; at temperature of 120 ºF yield points were 33 lb/100 $ft^2$and 28 lb/100ft^2; gel strength at 10 seconds were 9 lb/100 ft^2 and 8 lb/100 ft^2; gel strength at 10 minutes were 10 lb/100 ft^2 and 8 lb/100 ft^2 and at temperature of 150 ºF, 56 lb/100 $ft^2$and 43 lb/100ft^2; gel strength at 10 seconds were 13 lb/100 ft^2, 11 lb/100 ft^2; gel strength at 10 minutes were 17 lb/100 $ft^2$and 11lb/100 ft^2. The optimal drilling fluid can be likened to a fluid whose carry capacity is not altered by other additives used in the design. However, the yield points obtained with calcium carbonate water-based fluid were higher when compared with snail shell then means attention must be paid to the concentration of the lost circulation to be used to achieve the desired drilling fluid. The 10 seconds and 10 minutes gel strength exhibited similar trends for the three designs of water-based drilling fluids when subjected to higher temperatures. However, it has proven the fact that most of the fluid loss additives have an effect on the yield point and gel strength meaning attention must be paid to the rheological properties of water-based drilling fluids formulated with fluid loss additives irrespective of the number of viscosities used.

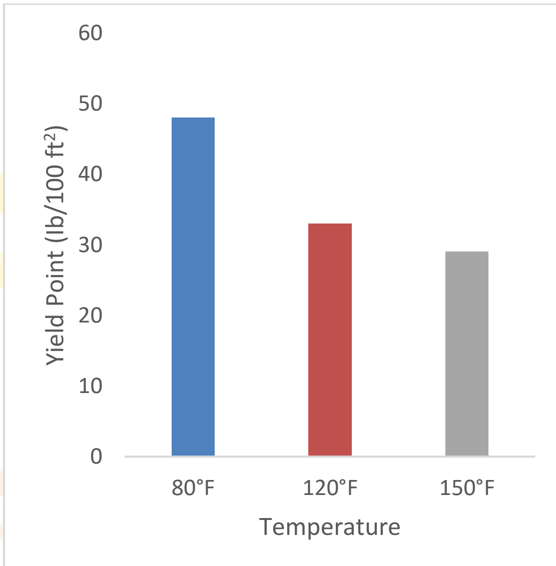

Figure 5: Yield Point vs Temperature of Snail Shell Water-Based Drilling Fluid

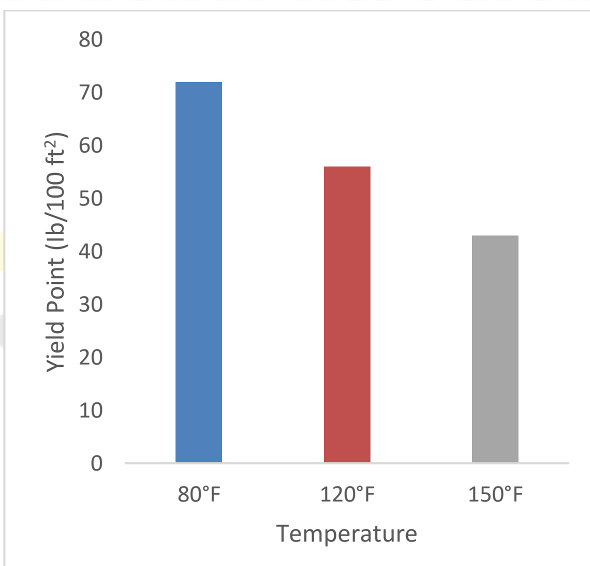

Figure 6: Yield Pointy vs Temperature of Calcium Carbonate Water-Based Drilling Fluid

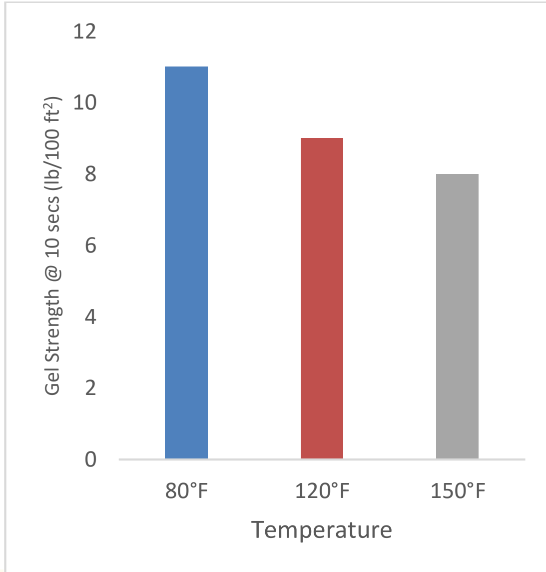

Figure 7: 10 Seconds Gel Strength vs Temperature of Snail Shell Water-Based Drilling Fluid

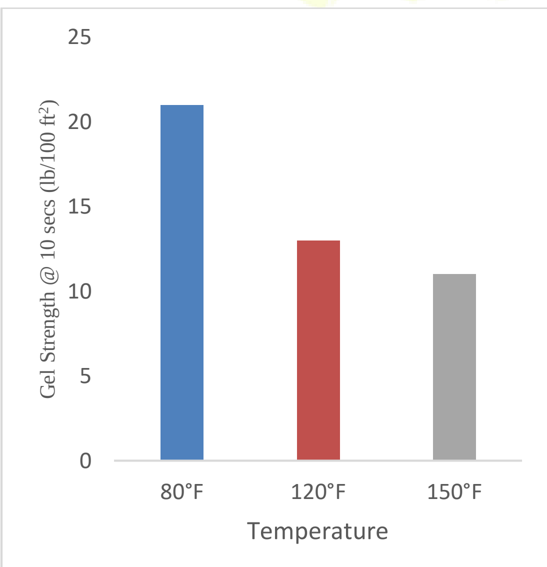

Figure 8: 10 Seconds Gel Strength vs Temperature of Calcium Carbonate Water-Based Drilling Fluid

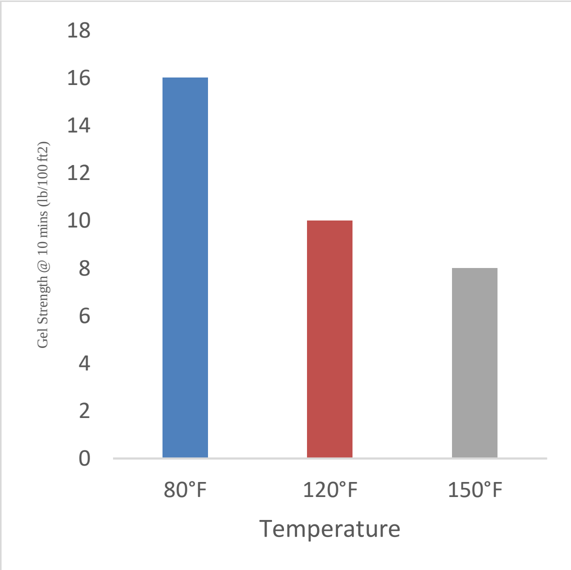

Figure 9: 10 Minutes Gel Strength vs Temperature of Snail Shell Water-Based Drilling Fluid

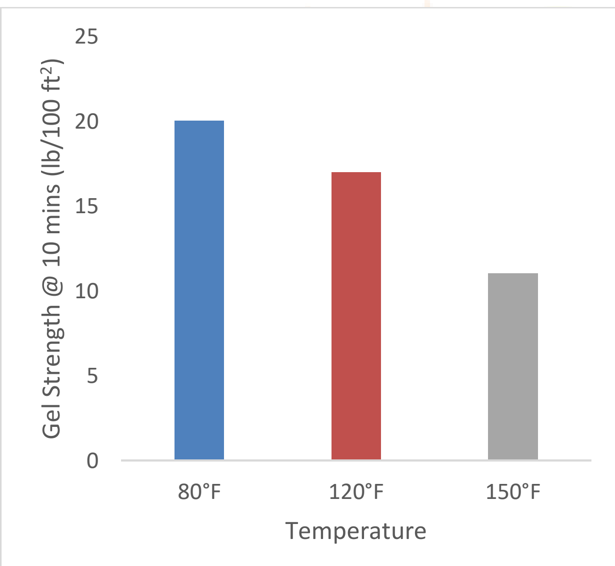

Figure 10: 10 Minutes Gel Strength vs Temperature of Calcium Carbonate Water-Based Drilling Fluid

Effect of Fluid Loss of water-based muds Formulated with Snail Shell and Calcium Carbonate

Oftentimes, when drilling in an unconsolidated or fracture formation drilling fluid tends to migrate into the formation and such a scenario can be prevented by the aid of an oilfield chemical such as a fluid loss control additive. Upon 3 grams of snail shell, and calcium carbonate it was observed that at ambient temperature there was a fluid loss of 6 ml/s, and 5.8 ml/s respectively. Experimental result on fluid loss volume has shown snail shell can be compared favorably with calcium carbonate meaning to snail shell is a better substitute for calcium carbonate in water-based drilling fluid design.

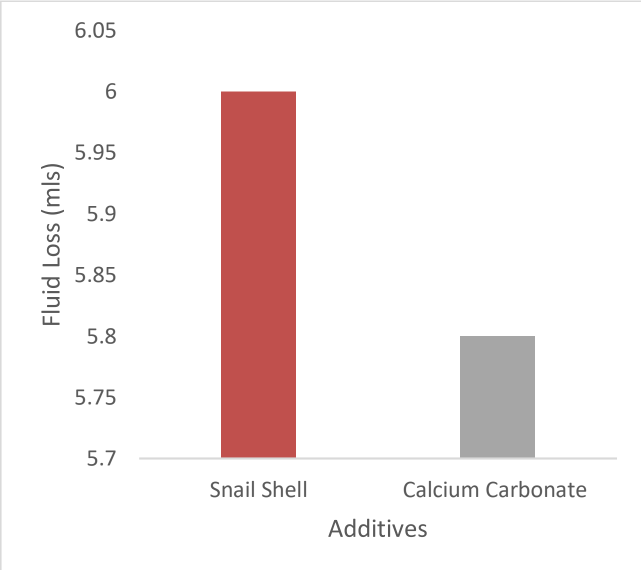

Figure 11: Fluid Loss vs Additives of Water-Based Drilling Fluid at Ambient Temperature

Characterization of Chemical Compound Composition of Snail Shell and Calcium Carbonate

X-ray diffraction is important in drilling fluid additives to understand the value of their mineralogy and their chemical compound composition. Snail shell contain chemical compound composition of aragonite 54, Lime 10.2, quartz 7.6, muscovite 6.9, vermiculite 15.7, albite 6.7 and orthoclase 5.2 whereas Calcium Carbonate contains lime 1.22, quartz 30, orthoclase 8.4, albite 0.3 and calcite 60. The percentage composition of snail shell is aragonite 4, Lime 14, quartz 6, muscovite 11, vermiculite 17, albite 11 and orthoclase 7 while Calcium Carbonate contains lime14, quartz 4, orthoclase 18, albite 9, and calcite 5. Experimental results have proven why snail shell and calcium carbonate have similar performance when being used in water-based drilling fluid design. However, the crystallographic structures are different, which implies that their electronic or elastic properties will be different also non-uniform spacing exist and which lead to having different wave pattern in the peak as shown in Figures 12 and 13 and also the pie charts depict it as shown in Figures 14 and 15. These results have shown the reason why water-based drilling fluid designed with snail shell has similar fluid loss and rheological trends with calcium carbonate.

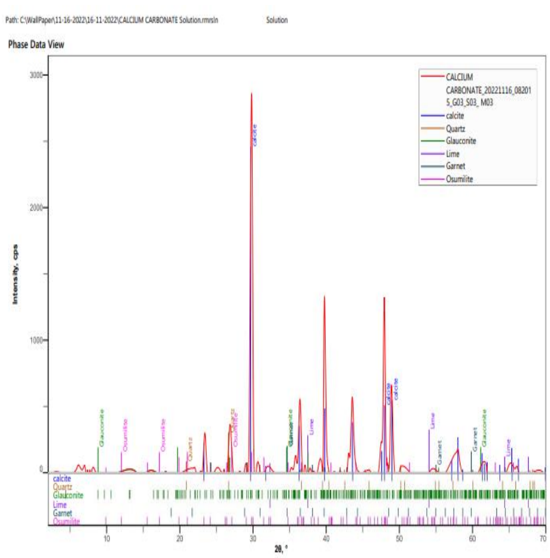

Figure 12: Graph showing Peak of XRD of Calcium Carbonate

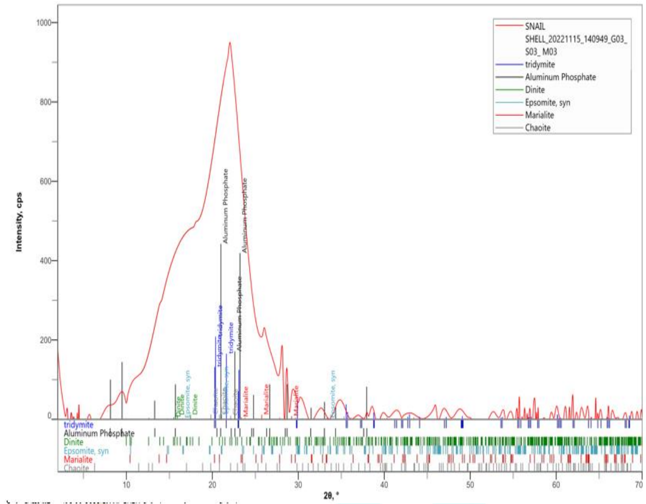

Figure 13: Graph showing Peak of XRD of Snail

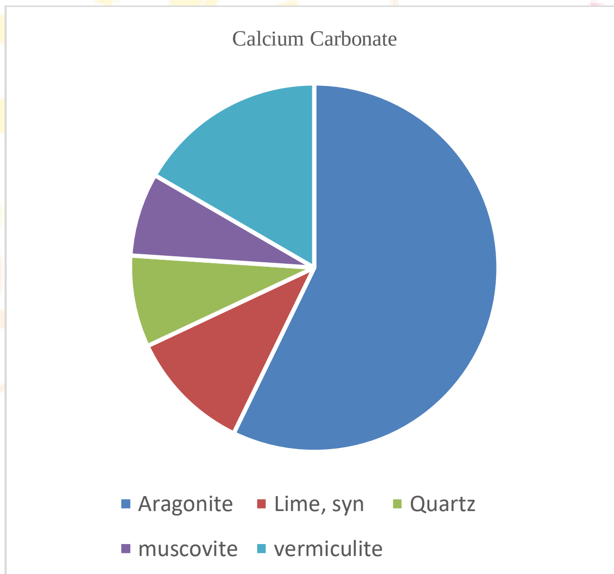

Figure 14: Pie chart of XRD showing the chemical composition of Calcium Carbonate

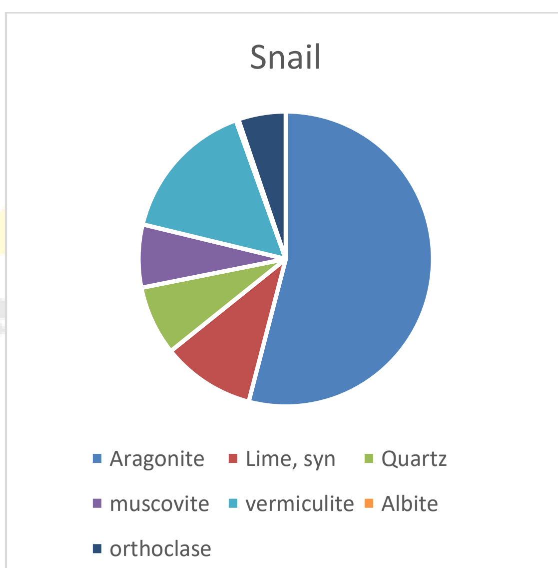

Figure 15: Pie chart of XRD showing the chemical composition of Snail Shell

Characterization of Elemental Composition of Snail Shell and Calcium Carbonate

It is essential to identify the presence of elemental compounds and oxide in drilling fluid additives and it can be achieved with the aid of X-ray fluorescence (XRF). It was observed that calcium carbonate Contains Calcium oxide (CaO) in abundance with a mole percentage of 77.403 and phosphorus pentoxide (P_2O_5) with 14.891; snail shell contains Calcium oxide (CaO) in abundance with 92.357-mole percentage and Aluminium Oxide (Al_2O_3) of 4.094-mole percentage;

Table 3: Result of Elemental Composition of Calcium Carbonate

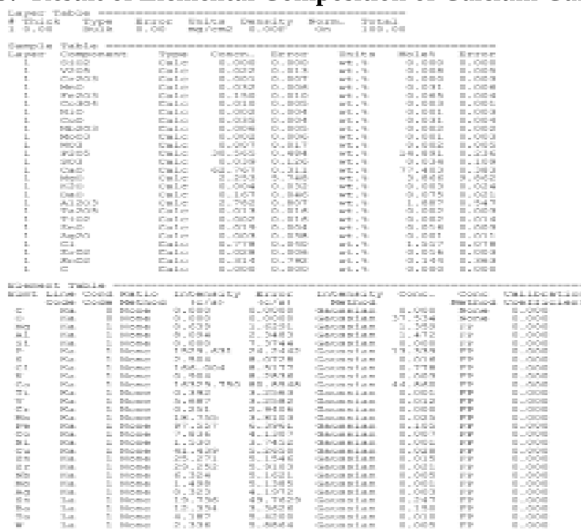

Table 4: Result of Elemental Composition of Snail Shell

Layer Table

#	Thick	Type	Error	Units	Density	Norm.	Total
1	0.00	Bulk	0.00	mg/cm2	0.00F	On	100.00

Sample Table

Layer	Component	Type	Concn.	Error	Units	Mole%	Error
1	SiO2	Calc	0.000	0.000	wt.%	0.000	0.000
1	V2O5	Calc	0.014	0.017	wt.%	0.004	0.005
1	Cr2O3	Calc	0.008	0.012	wt.%	0.003	0.004
1	MnO	Calc	0.054	0.011	wt.%	0.044	0.009
1	Fe2O3	Calc	0.280	0.019	wt.%	0.100	0.007
1	Co3O4	Calc	0.000	0.000	wt.%	0.000	0.000
1	NiO	Calc	0.023	0.007	wt.%	0.017	0.006
1	CuO	Calc	0.052	0.007	wt.%	0.038	0.005
1	Nb2O3	Calc	0.005	0.005	wt.%	0.001	0.001
1	MoO3	Calc	0.003	0.007	wt.%	0.001	0.003
1	WO3	Calc	0.004	0.024	wt.%	0.001	0.006
1	P2O5	Calc	0.000	0.000	wt.%	0.000	0.000
1	SO3	Calc	0.108	0.050	wt.%	0.077	0.036
1	CaO	Calc	92.357	0.483	wt.%	93.999	0.492
1	MgO	Calc	1.646	9.023	wt.%	2.331	12.778
1	K2O	Calc	0.274	0.045	wt.%	0.166	0.027
1	BaO	Calc	0.025	0.059	wt.%	0.009	0.022
1	Al2O3	Calc	4.094	1.352	wt.%	2.292	0.757
1	Ta2O5	Calc	0.014	0.026	wt.%	0.002	0.003
1	TiO2	Calc	0.000	0.000	wt.%	0.000	0.000
1	ZnO	Calc	0.004	0.005	wt.%	0.002	0.004
1	Ag2O	Calc	0.011	0.025	wt.%	0.003	0.006
1	Cl	Calc	0.420	0.035	wt.%	0.676	0.056
1	ZrO2	Calc	0.055	0.007	wt.%	0.026	0.003
1	SnO2	Calc	0.549	1.172	wt.%	0.208	0.444

Element Table

Elmt	Line Code	Cond Code	Ratio Method	Intensity (c/s)	Error (c/s)	Intensity Method	Conc.	Conc Method	Calibration Coefficient
O	Ka	0	None	0.000	0.0000	Gaussian	29.301	None	0.000
Mg	Ka	1	None	0.350	1.9210	Gaussian	0.993	FP	0.000
Al	Ka	1	None	9.172	3.0289	Gaussian	2.167	FP	0.000
Si	Ka	1	None	0.000	3.5185	Gaussian	0.000	FP	0.000
P	Ka	1	None	0.000	3.0790	Gaussian	0.000	FP	0.000
S	Ka	1	None	7.945	3.7160	Gaussian	0.043	FP	0.000
Cl	Ka	1	None	101.555	8.3768	Gaussian	0.420	FP	0.000
K	Ka	1	None	76.006	12.3516	Gaussian	0.227	FP	0.000
Ca	Ka	1	None	21906.970	114.6759	Gaussian	66.008	FP	0.000
Ti	Ka	1	None	0.000	2.8566	Gaussian	0.000	FP	0.000
V	Ka	1	None	2.385	2.9660	Gaussian	0.008	FP	0.000
Cr	Ka	1	None	2.212	3.3019	Gaussian	0.005	FP	0.000
Mn	Ka	1	None	22.032	4.6504	Gaussian	0.042	FP	0.000
Fe	Ka	1	None	129.330	8.6131	Gaussian	0.196	FP	0.000
Co	Ka	1	None	0.000	4.9679	Gaussian	0.000	FP	0.000
Ni	Ka	1	None	16.637	5.4431	Gaussian	0.018	FP	0.000
Cu	Ka	1	None	46.046	6.5688	Gaussian	0.042	FP	0.000
Zn	Ka	1	None	3.553	5.1682	Gaussian	0.003	FP	0.000
Zr	Ka	1	None	62.329	8.2077	Gaussian	0.041	FP	0.000
Nb	Ka	1	None	5.932	6.1989	Gaussian	0.004	FP	0.000
Mo	Ka	1	None	3.278	6.5739	Gaussian	0.002	FP	0.000
Ag	Ka	1	None	2.708	6.0383	Gaussian	0.010	FP	0.000
Sn	La	1	None	33.142	70.8133	Gaussian	0.432	FP	0.000
Ba	La	1	None	1.241	2.9611	Gaussian	0.022	FP	0.000
Ta	La	1	None	3.692	6.7021	Gaussian	0.012	FP	0.000
W	La	1	None	1.164	6.5263	Gaussian	0.003	FP	0.000

CONCLUSIONS

1. This research has shown that snail shells have good filtration (fluid loss) control properties.
2. The waste generated by disposing snail shells could be converted to wealth products found in abundance in the Niger Delta region of Nigeria.
3. No doubt, snail shells are better substitute to calcium carbonate in water-based drilling fluid design.

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REFERENCE

[1] Boek, E. S., Hall, C.,and Tardy, P. M. J. ―Deep Bed Filtration Modelling of Formation Damage Due To Particulate Invasion For Drilling Fluids,‖ Jan 2012 *In: Transport in Porous Media*. Vol. 91, no. 2, Jan 2012, pp. 479-508.
[2] Micheal, J. E., and Kenneth, G. N. ―Reservoir Stimulation.‖ Schlumberger Educational Services, Texas, 1989, pp. 565-580.
[3] Peden, J. M., Avalo, M. R., and Arthur, K. G. ―The Analysis of Dynamic Filtration and Permeability Impairment Characteristics of Inhibited Water Based Mud.‖ *SPE Fornation Damage Control Symposium*, Lafayette, Louisiana, SPE-10655-MS, 24-25 March, 1982.
[5] Methven, N. E., and Kemick, J. G. ―Drilling and Gravel Packing with an oil base fluid System.‖ *Journal of Petroleum Technology*, vol. 21, iss. 06, pp. 671-679, June 1969.
[6] Goode, D. L., Berry, S. D., and Stacy, A. L. ―Aqueous-Based Remedial Treatments for Reservoirs Damaged by Oil-Phase Drilling Muds.‖ *SPE Fornation Damage Control Symposium*, Bakersfield, California, SPE-12501-MS, 13-14 February, 1984.
[7] Schlumberger | Energy Glossary "Bridging Agent" https://glossary.slb.com/en/terms/b/bridging_agent, accessed on 22th August, 2022.
[8] Wikipedia, "Calcium carbonate," https://en.wikipedia.org/wiki/Calcium_carbonate, accessed on 22nd August, 2022.
[9] Mfonobony, D. (2023): "Types of Snails found in Nigeria" Types of Snails Found in Nigeria – Nigerian Infopedia
[10] EIONET (2009): "Waste Retrieved form http://scp.eionet.europa.eu/definition/waste on Octobe , 2012.
[11] Abati, B. (2013):" Waste to Wealth Potentials of Municipal Solid Waste: The Case of GA-East. Municipal Assembly, Ghana. M.Sc Project Report Presented to Faculty of the Graduate School of Asia Pacific Studies, Ritsumeikan Asia Pacific University
[12] Adetola, O.B, Odunlami, D., Fasanmi, S,A, Yinusa, G.O., Adedeji, I.A., Solaja, M.O., Popoo;a, D., Ogede, S., Ogunbote, O., and Sunmola, B. (2018: "Waste to Wealth Perspective: Identifying Waste Potentials for Small Scale Business Devolpment in Ogun Stae, Nigeria.. Agogo Journal of Humananties Vol 5. ISSN 2536-6890. Researchgate
[13] Jassim, A. K. (2017). Sustainable solid waste recycling. Skills development for sustainable manufacturing. In Tech. Available electronically at https://www.intechopen.com/books/skills-development-for-sustainable-Waste to Wealth Perspective: Identifying Waste Potential for Small Scale Business Development in Ogun State